

### **REMARKS**

The Official Action dated September 24, 2008 has been carefully considered. It is believed that the present Amendment places this application in condition for allowance. Reconsideration is respectfully requested.

By the present Amendment, claims 1, 15, 18 and 19 are amended to include limitations from claims 2, 5, 8, 9 and/or 11 and/or the specification at page 22, lines 1-4, and page 22, line 22-page 23, line 22. Claims 3 and 4 are amended for clarity and claims 4, 6 and 7 are amended to change their dependency. Claims 2, 5, 8, 9, 11, 12 and 17 are cancelled. Claims 1, 3, 4, 6, 7, 10, 13-16, 18 and 19 remain pending.

In the Official Action, claim 4 was rejected under 35 U.S.C. §112, second paragraph, as being indefinite on the basis that there was insufficient antecedent basis for recitation of “the liquid components (D1 and D2).” This rejection is traversed. Claim 4 now depends from claim 3 which provides antecedent basis for recitation of “the liquid components (D1) and (D2).” Claim 4 is therefore definite and the rejection under 35 U.S.C. §112, second paragraph, has been overcome. Reconsideration is respectfully requested.

Claims 1-4, 9-11 and 14 were rejected under 35 U.S.C. §102(b) as being anticipated by the Iwasaki et al U.S. Patent No. 4,769,442. The Examiner asserted that Iwasaki et al disclose the same polymerization reaction, whereby an alkaline compound such as methylamine is inherently formed and is then inherently removed in Iwasaki et al’s distillation of the organic solvent.

This rejection is traversed and reconsideration is respectfully requested. Applicants submit that Iwasaki et al do not teach, expressly or inherently, a process for producing a poly(arylene sulfide) as recited in claim 1, or claims 3, 4, 10, 13 and 14 dependent thereon.

More particularly, the process of claim 1 reduces the content of methylamine which can accumulate in a recycled organic solvent (B) used in a washing step in the production of poly(arylene sulfide) (PAS). As a result, the organic solvent (B) can be recycled for use without adversely affecting the properties of the PAS. Specifically, it has been determined that when a washing solvent such as acetone is repeatedly used in, i.e., recycled through or to, the washing step, the mere purification of the washing solvent by distillation does not sufficiently remove minute amounts of impurities such as methylamine that adversely affect the quality and physical properties of the formed PAS. Particularly, when the washing solvent is repeatedly recovered for recycle and reuse in the washing step, the PAS is undesirably colored, i.e., yellowed, and/or the melt viscosity of the PAS is lowered. Additionally, although it is known to treat formed PAS with an aqueous solution or organic solvent solution of an acid or a salt of a weak alkali and a strong acid, for example, ammonium chloride, in a post treatment step in order to raise the crystallization temperature,  $T_{mc}$  (also referred to as "melt crystallization temperature"), the  $T_{mc}$ -raising effect of the acid or salt is reduced when the washing solvent is repeatedly recovered by distillation for recycle and reuse through the washing step. A lower  $T_{mc}$  reduces the efficiency of molding operations since, for example, the cycle of injection molding is extended.

The present inventors have extensively investigated the PAS production process comprising heating and polymerizing a dihalo-aromatic compound and a sulfur source such as an alkali metal sulfide in an organic amide solvent, and have studied the production of alkaline compounds such as methylamine which are secondarily produced, presumably in the decomposition of the organic amide solvent. It has been found that when this alkaline compound

is mixed in a washing solvent, the compound is difficult to remove, even by distillation, and accumulates in the washing solvent during repeated use and recovery of the washing solvent.

Importantly, the present inventors have found that when an inorganic acid such as hydrochloric acid is added to the washing solvent recovered from the washing step to convert the alkaline compound such as methylamine to a salt with the inorganic acid, and distillation is then conducted, the content of the alkaline compound, which greatly adversely affects the physical properties of the PAS, can be effectively lowered. It has also been found that the content of alkaline compound such as methylamine can be significantly reduced in the washing solvent by treating the washing solvent with activated carbon. As a result, the inventors have shown that a washing solvent such as acetone may be recycled repeatedly (for example, at least several tens of times) while reducing the adverse influence on the physical properties of the formed PAS.

Accordingly, claim 1 recites, inter alia, a purification step of recovering the organic solvent (B) from the liquid component (C) by distillation, and thereafter purifying the recovered organic solvent (B) by i) adding an inorganic acid to the recovered organic solvent (B) and then conducting distillation again, or ii) bringing the recovered organic solvent (B) into contact with activated carbon and then conducting distillation again, to lower the content of methylamine mixed therein to be at most 3,000 ppm by weight, and a step of recycling the purified organic solvent (B) to the washing step of the poly(arylene sulfide).

Iwasaki et al disclose that PAS particles resulting from polymerization are separated from a polymer slurry in a separator 2 and first washed with an organic solvent (acetone or methanol) in a washing vessel 3 to separate the polyarylene sulfide particles from filtrate, after which the PAS particles are further washed with water and acetone (or methanol) in a washing machine 5 (see column 5, lines 16-25). Further, Iwasaki et al disclose that crystalline alkali chloride by-

product which is separated from the PAS is washed with acetone or methanol in a washing vessel 8, the crystalline alkali chloride E is discarded through a separator 9, and the separated acetone or methanol is preferably recycled to the separator 2. The organic solvent (acetone or methanol) recovered from the liquid after solid-liquid separation is put into a column 10 and then purified for re-use (D), and solids C are discharged from the bottom of the column 10 and then discarded (see column 5, lines 33-42). Finally, with respect to a purification method of the organic solvent, Iwasaki et al describe that the organic solvent used for the washing of PAS can be used repeatedly by recovering it by distillation (see column 4, lines 22-26).

Thus, while Iwasaki et al disclose the use of organic solvent such as acetone for washing PAS and distillation of the acetone prior to recycle, Iwasaki et al do not recognize that alkaline compounds such as methylamine accumulate in the acetone, even when purified by distillation, and adversely effect the resulting PAS. Contrary to the Examiner's assertion that formation and removal of methylamine is inherent in Iwasaki et al's process, when a washing solvent such as acetone is repeatedly used (i.e., "recycled through") in the washing step, the mere purification of the washing solvent by distillation does not permit sufficient removal of minute amounts of impurities such as methylamine that adversely affect the quality of a PAS formed, and the physical properties of the PAS after washing are adversely affected.

In this regard, the Examiner's attention is directed to the comparison of Referential Example 1 and Example 1 set forth in the present specification. Referential Example 1 employs simple distillation of the organic solvent (acetone) used for washing, according to the teachings of Iwasaki et al, and results in significant accumulation of methylamine impurity upon repeated recycling of the solvent. Accordingly, the Examiner's assertion that an alkaline compound such as methylamine is inherently removed in the process of Iwasaki et al is rebutted. In Example 1,

and the following examples, when aqueous hydrochloric acid is added to acetone recovered by simple distillation, and simple redistillation is then conducted, the content of methylamine contained in the acetone is significantly reduced. In a specific embodiment, the methylamine content can be more effectively lowered by adjusting the pH of acetone to preferably not more than 10.0, more preferably lower than 10.0. Iwasaki et al provide no teaching or suggestion of any additional step for removing methylamine, particularly by adding an inorganic acid to the recovered organic solvent (B) or bringing the recovered organic solvent (B) into contact with activated carbon, and then conducting distillation again, as recited in claim 1, or any improvement provided by such an additional step.

The Examiner's attention is also directed to a comparison of PAS of Examples 6-10 prepared according to the present invention, wherein the methylamine content in the washing organic solvent is maintained at a low level, and PAS of Comparative Example 1 prepared with washing organic solvent containing a high level of accumulated methylamine. The PAS of Comparative Example 1 exhibited a significant degree of yellowing and an undesirably reduced melt viscosity and Tmc.

Anticipation under 35 U.S.C. §102 requires that each and every element as set forth in the claims is found, either expressly or inherently described, in a single prior art reference. *In re Robertson*, 169 F.3d 743, 745, 49 U.S.P.Q. 2d 1949, 1950 (Fed. Cir. 1999). In view of the failure of Iwasaki et al to disclose a purification step in addition to the conventional distillation, and particularly the failure of Iwasaki et al to disclose a purification step of adding an inorganic acid to the recovered organic solvent (B) or bringing the recovered organic solvent (B) into contact with activated carbon, and then conducting distillation again, Iwasaki et al neither expressly nor inherently describe the process of claim 1. Accordingly, Iwasaki et al do not

anticipate claim 1, or any of claims 3, 4, 10, 13 and 14 dependent thereon, whereby the rejection under 35 U.S.C. §102(b) has been overcome. Reconsideration is respectfully requested.

Claims 12, 15, 17 and 18 were rejected under 35 U.S.C. §102(b) as being anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Iwasaki et al. The Examiner again asserted that the process of Iwasaki et al inherently removes the alkaline compound by passing the solvent through a distillation column.

This rejection is traversed and reconsideration is respectfully requested. That is, claim 15, like claim 1, recites a process for producing PAS, wherein an organic solvent (B) has its methylamine content reduced to be at most 3000 ppm prior to recycle into the washing step. Claim 18 more specifically recites a method for washing PAS obtained in a polymerization process employing organic amide solvent, wherein the methylamine content in recycled organic solvent (B) is reduced to be at most 3000 ppm. As discussed in detail above, Iwasaki et al do not recognize the methylamine content or its disadvantageous effects on the resulting PAS, and do not teach or suggest that recycled washing solvent should have at most 3000 ppm of methylamine. As shown in Referential Example 1, simple distillation as suggested by Iwasaki et al does not inherently provide such a washing solvent after repeated recycling. Accordingly, Iwasaki et al do not anticipate claims 15 and 18, or render these claims obvious, whereby the rejection under 35 U.S.C. §102(b) or §103(a) has been overcome. Reconsideration is respectfully requested.

Claims 5-7, 13, 16 and 19 were rejected as being obvious and unpatentable over Iwasaki et al in view of the Miyahara et al U.S. Patent No. 5,840,830 and further in view of the Miyahara et al WO 03/048231, although the Examiner has relied on the corresponding U.S. Patent Publication No. 2005/0087215. The Examiner acknowledged that Iwasaki et al fail to teach the

use of an inorganic acid/hydrochloric acid in the purification step and the dehydration of the sulfide/amide solvent mixture. However, the Examiner asserted that Miyahara et al '830 disclose a similar polymerization process wherein washing is done with an organic solvent and the polymer formed can be treated with an acid (referring to column 9, lines 49-63) and on that Miyahara et al '215 disclose a similar polymerization reaction wherein washing with acetone is conducted and the washing is treated with an acid, specifically HCl added to the solvent (referring to paragraphs [0047] and [0048]). The Examiner concluded it would have been obvious to have used Miyahara et al '830's acid in Iwasaki et al's cleaning treatment and to use Miyahara et al's '215's HCl as Miyahara et al '830's acid.

This rejection is traversed and reconsideration is respectfully requested. Claims 6, 7 and 13 depend from claim 1, and claim 16 depends from claim 15. Claims 1 and 15 have been discussed in detail above, as have the deficiencies of Iwasaki et al with respect to claims 1 and 15. Miyahara et al '215 and Miyahara et al '830 do not resolve these deficiencies and do not render the further limitations of claims 6, 7, 13 and 16, or the process of claim 19, obvious. In this regard, claim 19 recites a process for purifying an organic solvent used in washing, which comprises washing a PAS obtained by a polymerization step in an organic amide solvent (A) with an organic solvent (B) comprising of a ketone or alcohol, conducting sifting through a screen to separate the polymer from a liquid component (C) containing the organic solvent (B) used in the washing, recovering the organic solvent (B) from the liquid component (C) by distillation, adding an inorganic acid to the recovered organic solvent (B), and then conducting distillation again.

As discussed in detail above, Iwasaki et al do not recognize the methylamine content or its disadvantageous effects on the resulting PAS, and do not teach or suggest that an inorganic

acid should be added to the washing organic solvent before it is recycled to the washing step. Neither Miyahara et al reference provides such teachings either. That is, Miyahara et al '830 disclose at column 9, lines 49-63 that in the post-treatment, after completion of the polymerization reaction, the resulting polymer is washed with water and filtered repeatedly, and dehydrated or dried, and that a slurry containing a formed product may be subjected to sifting, after which the PAS may be washed with an organic solvent such as the same organic amide solvent, acetone or an alcohol, hot water, and/or the like. Miyahara et al '830 then disclose that the PAS formed may be treated with an acid or a salt such as ammonium chloride. Therefore, Miyahara et al '830 contemplate the acid or salt treatment of the PAS, subsequent to washing with an organic solvent. Applicants find no teaching or suggestion by Miyahara et al '830 that an acid is added to a washing solvent prior to its recycle to a washing step or that the washing step is conducted with an acid in the washing solvent.

On the other hand, Miyahara et al '215, in paragraphs [0047] and [0048], disclose a third washing unit which employs a solution of an acid in water or a solvent mixture of water as a major ingredient with a water-miscible solvent, such as an alcohol, to treat PPS particles with the acid. Miyahara et al '215 indicate that this treatment increases the Tmc. However, as noted above, if the PAS has been washed in previous steps with recycled organic solvent containing significant amounts of methylamine, the effectiveness of this type of treatment in increasing the Tmc is reduced. Miyahara et al '215 disclose that the washing liquid is a diluted acid that can be introduced into an acid recovery section or can be discharged out of the system as it is because it is substantially harmless. Importantly, Applicants find no teaching that any organic solvent from this acid solution is recycled for further use. Accordingly, one of ordinary skill in the art would



have no apparent reason, absent Applicants' specification, to combine the teachings of Miyahara et al '215 and Iwasaki et al along the lines of the claimed processes.

In determining patentability under 35 U.S.C. §103, it is necessary to determine whether there was an apparent reason to combine the known elements of the prior art in the fashion of the claims at issue, *KSR International Co. v. Teleflex, Inc.*, 127 S.Ct. 1727, 1740-41 (2007). Here, neither Miyahara et al '830 nor Miyahara et al '215 provide an apparent reason to add an inorganic acid to a recycled organic solvent used in a PAS washing step, particularly since neither reference, nor Iwasaki et al, recognize that methylamine content in the washing organic solvent accumulates as the solvent is recycled and is not removed by simple distillation. Accordingly, the combination of Iwasaki et al, Miyahara et al '830 and Miyahara et al '215 does not render claims 6, 7, 13, 16 and 19 obvious, whereby the rejection under 35 U.S.C. §103(a) has been overcome. Reconsideration is respectfully requested.

Finally, claim 8 was rejected under 35 U.S.C. §103(a) as being obvious and unpatentable over Iwasaki et al in view of Miyahara et al '830 and further in view of *Water Encyclopedia*, pages 350-352. The Examiner relied on *Water Encyclopedia* as teaching that passing solutions over activated carbon for removal of organic impurities is well known in the art. The Examiner concluded it would have been obvious to use activated carbon in Iwasaki et al's solvent cleaning.

This rejection is traversed and reconsideration is respectfully requested. Claim 8 has been cancelled from the application and its limitations now appear in claim 1. Claim 1 has been discussed in detail above, as have the deficiencies of Iwasaki et al and Miyahara et al '830 with respect to claim 1. The deficiencies of these references are not resolved by *Water Encyclopedia*. That is, while *Water Encyclopedia* teaches passing solutions over activated carbon for removal of organic impurities, none of the cited references recognize that an alkaline compound such as

methylamine is contained in the distilled washing organic solvent of Iwasaki et al. Accordingly, there would have been no apparent reason for one of ordinary skill in the art to combine the teachings of *Water Encyclopedia* with Iwasaki et al along the lines of the present invention and particularly to purify distilled organic solvent by i) adding an inorganic acid to the recovered organic solvent (B) and then conducting distillation again, or ii) bringing the recovered organic solvent (B) into contact with activated carbon and then conducting distillation again, to lower the content of methylamine mixed therein to be at most 3,000 ppm by weight, and a step of recycling the purified organic solvent (B) to the washing step of the poly(arylene sulfide). Hence, the combination of Iwasaki et al, Miyahara et al '830 and *Water Encyclopedia* does not render claim 1 obvious, whereby the rejection under 35 U.S.C. §103(a) has been overcome. Reconsideration is respectfully requested.

In the attachments to the Official Action, the Examiner indicated that certain non-U.S. references listed in Form PTO-1449 filed September 15, 2005 had not been received. Attached is Applicants' stamped receipt card showing receipt of the references by the U.S. Patent and Trademark Office. However, for the Examiner's convenience, duplicate copies are submitted herewith, together with a copy of the previous Form PTO-1449. As these references were previously provided, no fee under 37 C.F.R. 1.97 is believed due. In the event the Examiner determines a fee under 37 C.F.R. 1.97 is necessary to consider the references, please charge the same to Deposit Account 503915.

It is believed that the above represents a complete response to the Official Action and places the present application in condition for allowance. Reconsideration and an early allowance are requested.

Serial No. 10/540,834  
Amendment dated February 24, 2009  
Reply to Official Action dated September 24, 2008

Please charge any fees required in connection with the present communication, or credit any overpayment, to Deposit Account No. 503915.

Respectfully submitted,

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